Visions of Xanadu: Paul Otlet (1868–1944) and Hypertext

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The work of the Belgian Internationalist and documentalist, Paul Otlet (1868–1944), and his colleagues in Brussels, forms an important and neglected part of the history of information science. They developed a complex of organizations that are similar in important respects functionally to contemporary hypertext/hypermedia systems. These organizations effectively provided for the integration of bibliographic, image, and textual databases. Chunks of text on cards or separate sheets were created according to "the monographic principle" and their physical organization managed by the Universal Decimal Classification, created by the Belgians from Melvil Dewey's Decimal Classification. This article, discusses Otlet's concept of the Office of Documentation and, as examples of an approach to actual hypertext systems, several special Offices of Documentation set up in the International Office of Bibliography. In his *Traité de Documentation* of 1934, one of the first systematic treatises on what today we would call information science, Otlet speculated imaginatively about telecommunications, text-voice conversion, and what is needed in computer workstations, though of course he does not use this terminology. By assessing how the intellectual paradigm of nineteenth century positivism shaped Otlet's thinking, this study suggests how, despite its apparent contemporaneity, what he proposed was in fact conceptually different from the hypertext systems that have been developed or speculated about today. Such as analysis paradoxically also suggests the irony that a "deconstructionist" reading of accounts of these systems might find embedded in them the positivist approach to knowledge that the system designers would seem on the face of it explicitly to have repudiated.

Introduction

The development of hypertext/hypermedia systems has generated great interest in the last decade. The descriptions of what hypertext can do and what its implications are or will be for learning, science, information retrieval, creative writing, and so on, have frequently been extravagant to say the least. Most of those who discuss hypertext/hypermedia systems see the new functionality in information communication and retrieval that these systems involve as originating conceptually in Vannevar Bush's post World War II vision of an information storage and retrieval machine that he called "memex." This article suggests that much of this functionality was anticipated by a Belgian lawyer, bibliographer, and internationalist, Paul Otlet (1868–1944), and that his ideas and the systems to which they gave rise constitute an important chapter in the history of hypertext and in the history of information science more generally.

Otlet wrote eloquently of the need for an international information handling system embracing everything from the creation of an entry in a catalogue to new forms of publication, from the management of libraries, archives, and museums as interrelated information agencies to the collaborative development of a universal encyclopedia codifying all of man's hitherto unmanageable knowledge. Central to all of this were the Universal Decimal Classification, a new kind of information agency for information management called the Office of Documentation, a new principle of information indexing and storage, the "monographic principle," and microfilm. Ultimately he foresaw the creation of a Universal Network for Information and Documentation to which access would be had by multimedia workstations that lay waiting to be invented just beyond the technological capacity of his time. He developed these ideas in a large body of diffuse, repetitive writing dating from 1893. It will be seen that he is a precursor of Bush (1945), Englebart (1963), Nelson (1983, 1987), and others who have set the hypertext/hypermedia agenda in recent years and that he anticipated many of the features of Bush's memex, Nelson's Xanadu, and hypertext.

Vannevar Bush and Macrotext Systems of Hypertext

Discussions of hypertext and hypermedia tend to involve two levels, what Rada (1991) calls "macrotext" and "microtext." The former involves broad-based, networked systems involving many users and documents and document types, whereas the latter is highly focused and is concerned with a single system or document base. Most commentators place Vannevar Bush's speculations about memex at the imaginative source of hypertext. (e.g., Conklin, 1987; Eaves,

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1991; Ellis, 1991; Nyce & Kahn, 1991; Rada, 1991; Rada & Lunin, 1989). Bush was inspired by perceptions of need that are, as we shall see, similar to those that inspired Otlet and it is useful to examine Bush's ideas as a background for Otlet's.

Following a period of expanding scientific activity around the time of World War II, Bush had come to believe that "our methods for transmitting and reviewing the results of research" were no longer adequate. As the scientific specialization needed for progress increased, "the investigator is staggered by the findings and conclusions of thousands of other workers—conclusions which he cannot find time to grasp, much less to remember, as they appear." It seemed to him that "publication has been extended beyond our present ability to make real use of the record" (Bush, 1945, p. 89). In his view, as an engineer and scientist, the answer was to be found in harnessing technology to provide a sophisticated mechanical solution to the problem. Extrapolating from the technology of his time, Bush described a new kind of device which was a "sort of mechanized file and library." He called it a "memex." "A memex is a device in which an individual stores all his books, record, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory" (Bush, 1945, p. 102). All of the documents used in the memex would be in the form of microfilm copy acquired as such or, in the case of personal records, transformed to microfilm. Memex would also employ new retrieval techniques based on a new kind of associative indexing "the basic idea of which is a provision whereby any item may be caused at will to select immediately and automatically another" to create personal "trails" through linked documents. The new procedures that Bush anticipated facilitating information storage and retrieval would lead to the development of "wholly new forms of encyclopedia" (p. 103).

These ideas echo in subsequent statements. For Rada (1991) "the dream of hypertext is to connect text across more than one document boundary" (p. 108). For Conklin (1987) the desideratum is "macro literary systems... [which] support large online libraries in which interdocument links are machine-supported (that is, all publishing, reading, collaboration and criticism takes place within the network)" (p. 20). Rubens (1989) speaks of "optimistic scenarios for hypermedia [which] envision a world-wide network of hypermedia nodes which will allow users to research topics in various intellectual domains. The intent seems to be to create a platform that allows researchers to work together regardless of distance" (p. 19).

Perhaps one of the most imaginative, although quirkily expressed, forms of these sorts of ideas is embodied in Ted Nelson's Project Xanadu. "The Xanadu storage system," he tells us (Nelson, 1987), "is a new form of software with potentially revolutionary implications ... for personal computing, word processing, file management, the office of the future and its software, teleconferencing, electronic mail, electronic publishing, libraries of the future, and tomorrow's education." He sees it as offering "a plan for a world wide network, intended to generate hundreds of millions of users simultaneously for the corpus of the world's stored writings, graphics and data ... It is a design for a new literature, a system of order to make such a network understandable, useable, and readily expansible to any degree ... The Xanadu system provides a universal data structure to which all other data structures will be mapped." In what he calls a "medium-length description" of the Xanadu™ hypertext System (Nelson, 1983), he suggests that it "is a fast linking electronic repository for the storage and publication of text, graphics and other digital information; permitting promiscuous linkage and windowing among all materials; with special features for alternative versions, historical backtrack and arbitrary collaging..." (p. 3/2). Xanadu, like Bush's vision of "memex," has caught the imagination of commentators. As Rada and Lunin explain (1986): "It will provide for the deposit, delivery, and continued revision of linked electronic documents, servicing hundreds of millions of simultaneous users with hypertext, graphics, audio, movies, and hypermedia" (p. 160). For Conklin (1987), it would be "an online system which would eventually hold all of the world's literature" (p. 23); for Tsai (1988), a kind of "universal library of online text organized and indexed in new ways to facilitate the work of users" (p. 4).

Microtext Systems

At a different, "microtext" level of analysis, to use Rada's terminology, are particular hypertext systems: "Hypertext (hypermedia) consists of chunks or fragments of text or other information. Nodes and associative links are the basic building blocks of all hypertext systems ... Rather than a continuous flow of text, hypertext breaks it up into units or modules of information." The two essential features of hypertext are nodes and links. Because of the modularization of text, "nodes may be accessed in any sequence that meets the information needs of the user." Links connect the various chunks or nodes and "enable the user to determine the order in which information is presented. They enable the user to move around through hypertext." Links also provide connections between documents which can be in different media—written text, graphic text of various kinds and sound. An important feature of hypertext is the way in which the user can create links to and between nodes to reflect his or her own interests, prior knowledge and associations (Jonnasen, 1989, pp. 67–68).

Conklin (1987) has pointed out that the modularization of text involved in the creation of hypertext nodes correspond in some sense to the way in which we think of ideas, facts, and evidence and the way in which we break text into paragraphs. He comments on the way in which an idea in node form can become reified as a kind of manipulable object. He also relates nodes to semantic links: "Hypertext nodes can be thought of as representing single concepts or ideas, internode links as representing the semantic interdependencies among these, and the process

of building a hypertext network as a kind of informal knowledge engineering" (p. 36). He suggests that there are various types of nodes that can be identified according to their function. Links, too, are of various kinds. Some connect points in a dataset that can involve different media such as sound and film as well as text. Some are established by the system designer, others by the user.

In Tsai's view (1988) a central feature of the hypertext document is that users "can easily create personal browsing paths through the information space based on their own needs and interests" (Tsai, p. 4). This is an essential feature of hypertext. The system must provide a capability for nonsequential or nonlinear reading and writing. It allows readers to break away form the fixed linear sequence of conventional printed text. Movement through hypertexts does not depend on the original order of ideas imposed by authors on their texts according to their understanding of the subject at hand and their purpose in writing in the first place. It depends on the interests and purposes of the readers who are "navigating" the document according to the links that may be there already, having been provided by the system designer or other users, or created by themselves as they go along blazing their own "trails." But because the "structure" of conventional documents is not available and hypertext documents essentially have no logical beginning, middle or end, the result can be that, as users jump back and forth and between nodes of the systems, they can become disoriented and lost in "hyperspace." As a result, navigational systems of various kinds are needed to provide the kind of guidance implicit in the structure of conventional documents.

All of this reflects a fundamental process: documents created in a non-hypertext form, such as ordinary printed documents, have to be modified for the hypertext environment. What is to be identified as a node or a chunk and how this is to be done become important issues, especially if one moves from the creation of individual hyperdocuments to systems that will deal in new ways with the library's traditional information storage and retrieval problem involving many documents and document kinds. As Carlson (1989) puts it, the problem is that of resolving the complex relation of "rhetoric and knowledge structures," of "meaning and form" (p. 63).

We are not entirely inexperienced in dealing with the fundamental features of modern hypertext systems. Conklin (1987) suggests that a reference book such as a dictionary or encyclopedia is a kind of "manual hypertext"—"a graph of textual nodes joined by referential links" (p. 20). He also emphasises that the use of 3″ × 5″ card in note-taking leads to hypertext-like systems. Such cards are often given references to each other as well as arranged hierarchically. What is recorded is necessarily modularized into small chunks because of the size of the cards. The cards can be reorganized at will according to new systems or to include new information. It is presumably because the idea of the card is so apt as a metaphor for hypertext that the Xerox system, "the best known version of full hypertext" according to Conklin (p. 27), has been named Notecards, its designers explicitly inspired by Bush's vision of the memex (Trigg, 1991, p. 356). The note card was not a metaphor for Paul Otlet, as we will see, but an essential aspect of system technology.

"Something about Bibliography," 1892

Otlet's ideas go back to his desire as a relatively young man in his late twenties, not long out of college, and enjoying little success in the legal career for which his studies in Paris and Brussels had prepared him, to find ways of solving some of the problems created by the proliferation and disorderly state of the literature of the social sciences (Rayward, 1975, ch. 2). His first concern was with bibliography (Otlet, 1892). He was convinced that "the external makeup of a book, its format, the personality of its author were unimportant provided that its substance, its sources and its conclusions" become part of the collaborative organization of knowledge (p. 17). Bibliography, whose function was to assist in the identification and organization of source material, was simply the first step in a more general system of what might be called documentary processing. Exploring the ramifications of this system would ultimately lead Otlet to formulate plans for an International Documentary Network.

In this early work, Otlet suggested that literature could be analyzed so as to isolate four major categories of information: facts, interpretation of facts, statistics, and sources. An examination of each article or chapter of a book consistently along these lines, would reveal whatever in it that was a new contribution to knowledge. This information, essentially now in the form of "chunks," should then be collected on cards which would be minutely subdivided according to the subject relationships involved. Separate cards were an essential feature of the system technology that Otlet was envisaging. They allowed "all the manipulations of classification and continuous interfiling." In addition "a very detailed synoptic outline of knowledge" was needed as the basis for the arrangement of the catalogue that would be formed from the cards and to allow the coordination of collaborative work among scholars for its development (Otlet, 1892, p. 19). Eventually, the "detailed synoptic outline of knowledge" was to be provided by the expansions that Otlet and his colleagues would make to Melvil Dewey's Decimal Classification.

Traité de Documentation, 1934

In 1934, some ten years before Vannevar Bush published his ideas about a memex, some 35 or 40 years before Ted Nelson began to develop his ideas of a fabled information Xanadu, Paul Otlet published a magisterial work of synthesis, the *Traité de Documentation* (reprinted in 1989). This work culminated a lifetime's thinking, begun for Otlet 40 years before with "Something about Bibliography," about the problems of creating new, and improving existing, systems for organizing knowledge. The *Traité* is perhaps the first systematic, modern discussion of general problems of organizing information.

The term "documentation" is a neologism invented by Otlet to designate what today we tend to call Information Storage and Retrieval. In fact it is not too much to claim the *Traité* as one of the first information science textbooks.

The *Traité* begins with a long and exhausting general exposition about communication and information examined historically and from the point of view of various social and other sciences. It then proposes that new kinds of mechanical, integrated information handling systems should be invented that would transform the work environments and practices of scholars. Otlet's speculations, Like Bush's were prompted by a concern to deal with the ever-expanding growth of literature and the realization that a technological innovation was at hand to help. In Otlet's case it was perhaps a technology that today we might have difficulty recognizing as such, so ubiquitous—and in a sense passé—has it become. What fired his imagination was the realization of the bibliographical uses to which standard 3″ × 5″ card and later loose sheets or leaves of standard sizes could be put. Here was a simple technology to be exploited by those who had the imagination to see the potential implicit in it. Cards permitted the "analytical" recording of single, separate pieces of information, be they bibliographical or substantive, and so effectively the creation of what in hypertext are nodes or chunks of text. Larger chunks of information could be recorded on separate sheets. Otlet called this the "Monographic Principle" (Otlet, 1918).

The use of the term, monographic, was well chosen; etymologically it signifies a single or individual piece or unit of writing. It is possible that Otlet's use of the term derives from his involvement in Die Brücke or the Bridge, a society for the study of the organization of knowledge set up in Munich in 1911 with the famous German chemist, Wilhelm Ostwald, in the Chair. Otlet was named Honorary President of the society. The reciprocities in the relationship between Otlet, the Institut International de Bibliographie (IIB), Ostwald, and Die Brücke are in need of much further investigation. But Otlet's "Monographic Principle" echoes the Prizip der Monographisierung enunciated in the literature of Die Brüke and which led in the long run to the emergence of the German standard, now internationally accepted, for the size of paper sheets (Satoh, 1987). For Otlet, if cards and sheets were standardized especially as to size and weight, the collaborative, continuous expansibility of databases that were created in these media according to the monographic principle became possible. In theory it was easy to excerpt items in the databases or to duplicate them in whole or in part simply by copying the cards or sheets comprising them. Otlet and his colleagues were also responsible for the development of what we would call a highly flexible database management system for databases created from cards and sheets. This was the Universal Decimal Classification (UDC), the first of the great modern faceted classification systems which grew out of Otlet's discovery in 1895 of Melvil Dewey's Decimal Classification and his recognition of its potential for mapping knowledge domains and encoding complex subject descriptions.

The Organizational Context—IIB, RBU, UDC, and the Palais Mondial

The ideas expressed in Otlet's early papers arose out of the experience Otlet and his colleague, Henri La Fontaine, had had in the period from 1892 to 1895 in creating a number of social science bibliographies under the aegis of the Société des Sciences sociales et politiques in Brussels. The acquisition of a copy of Melvil Dewey's Decimal Classification in 1895 led them to explore the idea of developing by means of international cooperation an international bibliography that would be compiled on cards and classified by the Decimal Classification. Dewey agreed that they be allowed to expand and modify the Decimal Classification so that it would be appropriate for the detailed, bibliographic purposes that they had in mind. His proviso was that their version of the classification was not to be made available in English (and it was not until the mid-1930s). In its expanded form Dewey's Decimal Classification became known as the Universal Decimal Classification (UDC), the first complete edition of which was issued in the period 1904–1907.

In the fall of 1895, with support of the Belgian government, Otlet and La Fontaine summoned the first International Conference of Bibliography (there were to be five of these conferences before the First World War). The conference resolved to set up an International Institute of Bibliography (IIB), whose headquarters in Brussels would be known as the International Office of Bibliography (OIB), to which the Belgian government accorded a semiofficial status. Within the OIB would be assembled a great classified catalogue or database on cards. This was the Universal Bibliographic Repertory (RBU). In 1895 the two friends had compiled a sample database of 400,000 classified entries for the consideration of the International Conference of Bibliography. By April 1934 Otlet (1934) noted that the number of cards in the database was 15,646,346 (p. 405). The RBU was followed by other kinds of databases. First, in 1906, came a Universal Iconographic Repertory, an image database in which illustrative materials were assembled and mounted on cards or sheets of the standard size. By 1912 there were a quarter of a million items in this Repertory (Rayward, 1975, p. 154). Its purpose was to provide a pictorial dimension to the RBU. Like the RBU, items for the image file were classified and arranged by the Universal Decimal Classification in their special furniture. The next step was to observe that if textual materials were similarly assembled and classified, a substantive or what we might call a full text dimension would then be achieved in the repertories that were now bibliographical and pictorial. What was called the Encyclopedic Repertory of Dossiers (or files) was instituted in 1907. In it were assembled materials "relative to all the objects and all the facts which constitute human activity in its widest extension" (Rayward,

1975, p. 154). By 1914 it contained a million items in 10,000 files.

From the earliest days of setting up the Universal Bibliographic Repertory, Otlet and his colleagues stressed for its rapid and comprehensive development the importance of international cooperation in publishing bibliographies in the standard format, preferably on one side of a sheet and with each entry containing its UDC number. The publications could then be cut up and pasted onto cards for interfiling in the RBU. Not surprisingly they also stressed the value of, and themselves experimented with, actually publishing bibliographies on cards (Otlet & Vanderveld, 1906). Publications according to the various standardized requirements that they promulgated were considered to be part of a numbered series of *Contributions to the Bibliographia Universalis*. This actually reached considerable proportions in the period before the outbreak of the First World War (Rayward, 1975, ch. 6).

Later, similar emphasis was placed on the publication of "encyclopedic" material for direct use in the encyclopedic repertory. The Belgian Sociological Society, for example, in the period before the First World War, published an anthropological directory of primitive tribes in a volume with pages perforated at the margins for just this cumulating encyclopedic purpose. Otlet (1918) makes a passing reference to Nelson's *Perpetual Loose-leaf Encyclopedia* which first began to appear in 1905 which may have served as a model or example for him. An intriguing reference was also made in 1913 by the Berlin correspondent of the *Scientific American* to the Belgian encyclopedia experiments. He reports on the idea floated in Berlin of developing "An encyclopedia on the Card-Index system" in connection with the microphotographic library of Robert Goldschmidt, an engineer with whose experiments in the bibliographic applications of microfilm Otlet had collaborated since at least 1906. This casual reference raises again the connection between Die Brücke and Otlet and his colleagues. What is reported suggests that the Germans were exploring the idea of creating a working encyclopedia on the model proposed by Otlet (Encyclopedia, 1913).

The various databases actually set up by Otlet and his colleagues were all intended to be interrelated by their common standardized organizational methods, most especially by and through their arrangement by the UDC. Of course, explicit links between items in the repertories or databases were not made; each file had to be referred to separately for material on a given subject or in the course of a particular search. But the use of the UDC provided implicit, recognizable links between the files. A number assigned to an entry in one file automatically linked that entry to an entry bearing the same or a related number in another file.

An international search service for these databases was set up in the OIB, which was widely advertised and drew considerable business (Masure, 1912). Rudimentary instructions for formulating searches were drawn up. The retrieval effects of search terms that were either too general or too specific were described and it was suggested that requests should be formulated in terms of UDC numbers. In the Tables of the Classification "the degree of generality and specificity of each question is exactly determined by the context." Use of the Tables would prompt enquirers to both bibliographic completeness as well as exactness in the use of terminology. However, it was OIB policy that if a request was likely to produce more than 50 items users would be notified of this "to obviate surprise" (Communication des fiches, 1897). Searches continued to be made in the files—both bibliographic and image or iconographic—until the early 1970s when they became unavailable.

The International Institute of Bibliography, its headquarters organization supported by the Belgian government as the International Office of Bibliography, underwent a fascinating process of organizational elaboration as these and other functions were added to it. In 1905, the International Institute of Photography was created within it to receive the collections of Ernest de Potter, the editor of the *Revue belge de Photographie*. These collections formed the basis of the International Iconographic Repertory. In 1907, a Museum of the Press was also set up within the Institute under the joint sponsorship of the Union de la Presse périodique belge and the Cercle des Collectioneurs des Journaux. In that same year a number of learned societies in Brussels agreed to merge the collections of their libraries to form within the OIB what was at first called the Collective Library of Learned Societies and later, simply, the International Library.

In 1910, Otlet and his colleague, Henri La Fontaine, organized a huge International Conference of International Associations which created the Union of International Associations (UIA). The conference was held on the occasion of a World's Fair at Brussels and a number of the exhibits were acquired and centralized by Otlet and La Fontaine as the nucleus of an International Museum which they attempted to continue to develop over the years. The Belgian government provided new locations in 1910 in the Palais du Cinquantenaire for the Museum. In the next few years all of the components of the complex or organizations created by Otlet, La Fontaine and their colleagues were gradually centralized in these locations. Otlet named them the Palais Mondial (World Palace) or Mundaneum. For Otlet, conceptually, they were all interrelated aspects of what was required organizationally to develop effective international intellectual life. After the first World War the last of the components of the Palais Mondial or Mundaneum flickered into life, an International University. This was no more than a glorified summer school that met in the Palais Mondial three times in the early 1920s before disappearing from sight.

A 1914 pamphlet in English describes what this new organization was intended to achieve:

> The International Centre organises collections of world-wide importance. These collections are the International Museum, the International Library, the International Bibliographic Catalogue and the Universal Documentary Archives. These collections are conceived as parts of one

universal body of documentation, as an encyclopedic survey of human knowledge, as an enormous intellectual warehouse of books, documents, catalogues and scientific objects. Established according to standardized methods, they are formed by assembling cooperatively everything that the participating associations may gather or classify. Closely consolidated and coordinated in all of their parts and enriched by duplicates of all private works wherever undertaken, these collections will tend progressively to constitute a permanent and complete representation of the entire world. (Union of International Associations, 1914, p. 116)

Hypertext: Nodes, Chunks, and the Monographic Principle

The databases or repertories, the collections of books and objects that were assembled within the OIB and later the Palais Mondial or Mundaneum were all related by common methods and a common "philosophy" of organization. An examination of the ideas and procedures that governed their development suggests how similar what was intended was to hypertext systems. The repertories or databases consisted of nodes or chunks organized by a system of links and navigational devices that allowed the movement of the user from bibliographic reference to full text to image and object. Ultimately, as we will see, Otlet speculated about a new kind of technology that would make the kinds of prototype systems developed in the OIB available internationally using what we now call telecommunications.

Recording information in separate chunks or units according to the "monographic principle," could be applied to bibliographical references on cards and substantive information on standardized separate sheets. The idea was to "detach what the book amalgamates, to reduce all that is complex to its elements and to devote a page to each. Pages here are leaves or cards according to the format adopted" (Otlet, 1918, p. 149). After all, at one level, a book was simply a "single continuous line which has initially been cut to the length of a page and then cut again to the size of a justified line." Otlet suggested that the "repertories"—in modern terminology, the databases—that he and his colleagues were developing provided "a practical means of physically dividing the book according to the intellectual division of ideas" and obviating authorial peculiarities that obscured what was new and important in what was being presented.

These databases had become necessary, he believed, for two reasons. First they responded to the need to provide a new kind of reference or consultation function that had arisen as a result of contemporary pressures of publishing. "Once one read; today one refers to, checks through, skims. *Vita brevis, ars longa!* There is too much to read; the times are wrong; the trend is no longer slavishly to follow the author through the maze of a personal plan which he has outlined for himself and which in vain he attempts to impose on those who read him" (Otlet, 1903, p. 79). "It is necessary to be able to read a scholarly book by scanning it and easily eliminating from attention whatever is of no interest" (Otlet, 1989, p. 99). "The form of the book is distinct from its substance" (p. 94). The problem was how to release the substance from the particular bibliographic and literary forms in which it was expressed. In other words, the structure of conventional documents was too constraining and their content had to be, as it were, liberated by decomposing and recomposing them according to the monographic principle. This is the problem, to use Carlson's words quoted above, of rhetoric and knowledge structures, of meaning and form.

Second, these systems not only provided the new "consultation" function that Otlet saw as so important for contemporary retrieval systems, they also tended to highlight a range of inadequacies in existing systems. The new systems synthesized and allowed for the correction of what was increasingly fragmented and error prone. Consultation implied access to many sources, but these, in all their variety, were separate from one another, idiosyncratically organized and filled with error. They are, he declared in 1903, "mixtures of what is repetitive, preliminary, and for reference..." (p. 84). Some 30 years later, when analyzing in the *Traité de Documentation* the problems presented by books, he observed (1934):

(a) books present only some of the scientific data and so only a part of science (the incompleteness of books); (b) they present false as well as true knowledge (the errors of books); (c) they present the same thing more than once (repetitions); (d) they do not bring together information that is set out in several places, but divide it up and scatter it in innumerable volumes (fragmentation and dispersion); (e) they do not present the information set out according to its degree of importance (a mixture of the primary and secondary). (p. 373)

Techniques of the kind he proposed would provide a solution to all of these problems.

The idea of continuously, cooperatively elaborated databases growing from the decomposed texts of "the innumerable books on the subject matter of each discipline," led Otlet (1903) to think that they could form what might be called the "Universal Book" for each discipline.

This book, the 'Biblion,' the Source, the permanent Encyclopedia, the Summa, ... will constitute a systematic, complete, current registration of all the facts relating to a particular branch of knowledge. It will be formed by linking together materials and elements scattered in all relevant publications. It will comprise inventories of facts, catalogues of ideas and the nomenclatures of system and theories. It will condense various scientific data into tables, diagrams, maps, schemas. It will illustrate them by drawings, engravings, facsimiles and documentary photographs. (p. 83)

In the *Traité* he described more systematically the several levels materials and information that this new kind of encyclopedia would contain. There would be "encyclopedic documentary files" which would be made

up of pamphlets and extracts or parts of publications without any further processing. Analogous to these files would be card files differing from the documentary files only in size and the extent of the otherwise unprocessed items of information recorded on them. A third kind of input would be encyclopedic cards or sheets which would contain information that had been published in such a way that the cards or sheets could be incorporated directly into the encyclopedia. A fourth kind of input would be "encyclopedic atlases" which were not atlases in the conventional sense, but rather tables and charts schematizing diagrammatically major components of the encyclopedia. They could be considered to form a kind of navigational system in and between the various databases involved. Otlet placed great importance both for educational purposes and for clarifying and stimulating thought on the use of schemas, diagrams, charts, and tables. They helped identify and visualize concepts and concept relationships. Otlet's colleague with whom he worked closely over the years and with whom he shared this interest, the Scottish town planner and sociologist, Sir Patrick Geddes, called them "thinking machines" (Boardman, 1978; Rayward, 1975).

Finally, there was "the ultimate work of documentation" involving a process of "encyclopedic codification" that required "condensing, generalizing and synthesizing" data related to knowledge and action (p. 409). The new kind of universal encyclopedia in which all of these kinds of material would be incorporated would be collaboratively developed according to internationally adopted methods. It would be a great cadastral survey of learning in which all developments in knowledge would be reported and recorded day by day. It would be the culminating work of an international documentary network (Otlet, 1903, p. 83).

Thus did Otlet early in the century envisage the kind of encyclopedia the idea of which independently attracted H. G. Wells's interest in those last few fateful years before the outbreak of World War II (Rayward, 1992, 1994; Wells, 1938). It was an idea of encyclopedia not greatly dissimilar form that about which Bush was to speculate in the context of memex during the war years. For Otlet, the origins of the idea lay in his "scientific" analysis of documentary forms, his identification of the intellectual and physical elements comprising books and other documents, and the potential for the systematic organization and reorganization of knowledge inherent in the application of the monographic principle to standardized cards and sheets.

Hypertext: Links, Navigational Systems, and the UDC

The monographic principle applied to standardized cards and sheets represented one of the two major components of modern hypertext systems—nodes. The other, links and navigational systems, is reflected in the transformation by Otlet and his colleagues of Melvil Dewey's Decimal Classification system into the Universal Decimal Classification system. This was to become what Carlson (1989) has identified as one of the essential components of a hypertext information storage and retrieval system—"an assistance processor: a retrieval mechanism (or collection of retrieval mechanisms) for effective access to and management of the database" (p. 62–63).

UDC numbers for classes and divisions formed numeric codes. In these codes, "the links, the genealogy even, of ideas and objects, their relationships of dependence and subordination, of similarity and difference, find suitable representation..." (La Fontaine & Otlet, 1895, p. 34). They thought that the numbers "constitute a veritable new language whose phrases, here numbers, are formed according to constant syntactical rules from words, here numerals... they translate ideas absolutely common to the entire scientific world and express them in universally understood signs—numbers. In this twofold way the Decimal Classification actually constitutes and international scientific language, a complete system for representing science." The claim was even made that the numbers "followed the laws of scientific logic" (p. 34).

While Otlet and La Fontaine made a clear distinction between the classification of knowledge and bibliographic classifications, the latter being used essentially for the location of documents, the linguistic potential of the UDC led Otlet and his colleagues to elaborate its synthetic or faceted features. "As a classification," Otlet observed (1896), it must present a framework in which ideas can be successively subordinated to each other in different ways... As a bibliographic notation, it must be a veritable pasigraphy able to interpret by numerals grouped into factors having a separate and permanent meaning, all the nuances of ideologico-bibliographical analysis" (p. 59). The factors could be derived from auxiliary tables or from elsewhere in the classification, their use being marked in every case by a particular sign of association. By describing the UDC as a "pasigraphy," Otlet stressed its function as a system of knowledge representation designed for international use in which characters, such as numerals, represent ideas directly rather than standing for words.

The UDC fulfilled the requirement that Otlet had formulated in 1893 for a "synoptic outline of knowledge" (p. 19), "an immense map of the domains of knowledge" (Otlet, 1918, p. 78). Conceived of in this way and subjected to the developments that made it one of the first faceted classifications, the UDC's function was to encode what were essentially extended statements of what documents were about. Navigation in and between whatever special or general files or repertories were created from these documents or document descriptions required an understanding of how these codes worked. The general structure of the numbers comprising the codes was readily intelligible—and memorizable—for orienting the user generally in the files. To use a contemporary example (La Fontaine & Otlet, 1895):

> All the works concerning electricity are numbered 537. The first numeral, 5, indicates that the subject is related to the fifth class of knowledge, that is to say, to science. The second numeral determines what division

> of science is in question. Here it is the third division to which, conventionally, the number 3 is given. All the works of physics are, therefore, marked, 53. But physics itself is broken into different sections, of which the seventh is electricity, according to a uniform, previously established classification. When the numeral 7 is added to the number 53 it individualizes it and 537 indicates works which deal only with electricity. (p. 34)

The basic subdivisions were clear: the one, two, or three numbers that came before the decimal point indicated major classes or divisions and it was relatively easy to follow the sequence of numbers after the decimal point, no matter the degree to which they were elaborated: they formed a simple numerical sequence until interrupted by a sign of association of some kind. A series of auxiliary tables was prepared to represent common subdivisions by bibliographic form, language, chronology, point of view, proper name, and place, each having its own distinctive sign or marker (Rayward, 1975, ch. V). Complex numbers were created by using the special signs of association and other signs of abbreviation with numbers derived from the auxiliary tables of the common subdivisions and subdivisions derived from the main Tables. The result could be very long and complex numbers. S. C. Bradford (1950), an ardent supporter of the UDC, declares that the creation of an expression such as

526.9 : 336.211(431)"1927" =

3 (Guide to Prussian cadastral surveying in 1927)

is "justly described as 'not classification but idle jesting' " (p. 39). But it is not untypical of UDC numbers that he and others habitually elaborated.

Not only was there a problem in identifying and interpreting the parts of numbers, as a whole they presented great filing difficulties. Filing order was necessarily arbitrary and hard to remember. It became a problem for extremely complex numbers comprising several "factors" at the point where these factors were attached to the basic number. The problem was compounded by several procedures for presenting long numbers in abbreviated form. In one of the earliest reports on this matter (*Annuaire,* 1902), filing order is shown as: number to be subdivided followed by ( ), " ", ., =, :, --, A-Z, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

In theory, the constituent elements of complex numbers, the factors, were intended themselves to be searchable individually so that numbers representing complex ideas could provide multiple points of entry to the database depending on the interests and needs of the enquirer. As John Metcalfe (1959) has demonstrated, taking up a comment of Bradford's (1950) about "a small logical defect in the structure of the Decimal Classification" (p. 33), this sort of flexibility in searching was not possible in practice except for whole numbers reversible around the colon (:). This difficulty pointed up more clearly than anything else the limitations of the technology of cards and cabinets to which Otlet and his colleagues were restricted. Nowadays, in the computer age, the number-compounding and synthesizing conventions of the UDC can be used in searching in such a way that they actually fulfill the functions for which they were originally devised a century ago (e.g., Buxton, 1990).

One further requirement had to be met for the databases to become operational and this led to the introduction of additional navigational aids for the guidance of potential users. It was necessary that the cards and sheets on which the chunks of text—bibliographic, substantive, graphic, or pictorial—were recorded, be housed or contained. Standard catalogue furniture and filing cabinets had to be designed and manufactured to "embody" the various repertories being assembled. This furniture was an essential part of the system. It was produced to specifications put out by the OIB by a Belgian manufacturing firm and was advertised for general use in many of the International Institute of Bibliography's publications (e.g., *Annuaire*, 1902).

As materials were added to the databases and accommodated in the appropriate cabinets, divisionary cards of different heights and colors were introduced to indicate in a systematic way where major segments of the files fell—orange cards to indicate specific subjects and the relational subdivision, blue to indicate form divisions, green for divisions according to place, and so on. The numbers for the major classes and subclasses were recorded on lugs staggered along the edge of the divisionary cards protruding above the "content" cards. In effect the system of divisionary cards provided an important series of navigational devices for orienting users to the gross pattern of organization of what rapidly became large, complex, and related files. All of these matters are described in great detail in the *Manual for the Universal Bibliographic Repertory*, A huge volume of more than 2000 pages issued with varying dates in the period 1904–1907, it included the first complete edition of the UDC (*Manuel*, 1907; Rayward, 1975, ch. V).

Yet a third general navigational or mapping device consisted of the diagrams and schemas mentioned above. Such "atlases," as we have seen, were to be a feature of the innovative form of encyclopedia that Otlet proposed as the culminating objective of the new information storage and retrieval discipline, Documentation, that he was formulating. Schemas displayed in simplified, visual form the intricate relationships of the concepts embraced within various subject areas. A number of these schemas and charts were actually drawn up to help the conceptual orientation of users and to encapsulate the relationships between the databases and collections that Otlet and his colleagues had created in Brussels. Some of the diagrams were reproduced in a number of IIB publications. Gresleri and Matteoni (1982) have also recently used a number of them as representing in striking summary form aspects of Otlet's view of the organization of knowledge and the nature and relationships of international organizations and institutions.

Offices of Documentation as Hypertext Systems

Perhaps the nearest that Otlet and his colleagues came to developing working hypertext systems—microtext in

Rada's terminology—of limited scope and special application were several documentary services created within the International Institute of Bibliography around 1908. These services were set up ostensibly under the sponsorship of the International Polar Institute, supported by the Belgian government, and the International Associations for Hunting, Fishing, and Aeronautics. Mirroring the repertories in the International Institute of Bibliography, each of these International Offices of Documentation was to develop as complete a bibliographic repertory as possible in its specialist area. Each of the offices was to assemble a comprehensive library and a repertory of illustrative material—photographs, drawings, and prints. And each was also to develop a substantive repertory in which "documentary evidence will be classified on separate sheets... [this repertory] will contain extracts of literary works, separate articles, cuttings from newspapers, parliamentary documents, reports, prospectuses of industrial establishments and diverse manuscripts..." (Rayward, 1975, p. 155). A vast manual labor of indexing, transcription and excerpting was actually begun for these offices. Effectively the texts treated in this way were being modularized into nodes that would be recorded according to the requirements of the monographic principle. Searching in the various files in these documentation services was possible through the system of links implicit in the flexible, synthetic mechanisms provided by the UDC and by the other navigational devices described above.

Louis Masure (1912), Secretary to the IIB, gives an account of the status of the work of these offices as of 1912. The International Office for Hunting, to take one example, was involved in the "the classification, preservation, and communication" of all of the publications received in the office—"books, brochures, periodicals, newspapers, documents, prints, engravings, maps and manuscripts." Laws and regulations from various countries were to be translated; all hunt related periodicals were to be indexed; and information and copies of documents supplied upon request. By 1912 nearly 11,000 bibliographic entries had been prepared. Some 6,000 documentary items in a small card format had been created, mostly related to legislation. There were, however, over 30,000 items in the large sheet format. The pictorial or iconographic documentation consisted of 3,000 items. In addition was a file of over 21,000 entries derived from stock or stud books. Masure shows each of these major categories of documentation broken down into detailed subdivisions by UDC number. There were about 1,000 items in the small documentary format, presumably held in their own special filing cabinets, listed as being filed at 63.67.1, hunting dogs. There were slightly more than 1,700 items in the large documentary format at that number, again presumably in their own special filing cabinets. Some 300 pictorial items are listed as being at that number in the iconographic file. There would also have been in addition a set of bibliographic cards in the classified part of the catalogue at that number (these are not specified by category in the report) as well as books on the library shelves. The files derived from the stud books are for dogs in general at 63.67. A special section in the International Museum was also set up to receive objects of various kinds related to hunting. It is not clear that these special information services or Offices of Documentation had much life beyond the outbreak of the First World War.

For Otlet, however, Offices of Documentation were a new organizational phenomenon for processing and disseminating information. Regardless of the short life and imperfect implementation of the actual offices that he and his colleagues had attempted to create, the idea of such offices was central to his speculations about the organization (and reorganization) of knowledge. Offices of Documentation, Otlet thought, might draw on, but would transcend, the inadequacies of contemporary libraries. As early as 1903 he suggested that they would "form annexes or organizations complementary to libraries" (Otlet, 1903, p. 84). Later he suggested that Offices of Documentation had arisen because libraries had become slow to acquire new kinds of documents that did not conform to conventional categories (Otlet, 1934). They had not adopted the most advanced technical processing methods, including new methods of classification and cataloguing. They were deficient in not providing the specialist information services their users needed. In the future, however, "now that the work of excitation, propulsion, and creation has been carried out" (p. 414), Otlet thought that libraries, no longer limited to traditional catalogues giving traditional access to books and periodicals arranged in straight lines on conventional shelves, would function as Offices of Documentation.

What is distinctive about the Office of Documentation described by Otlet is the fact that its active information processing, reordering, restructuring functions were paramount. Over the years, Otlet (e.g., 1918) came back again and again to this idea, expressing it in different ways and in different contexts. Books were no more than raw materials that "must be developed more fully. This development consists in establishing the connections each individual book has with all the other books and forming from them what might be called the Universal Book." The "dissection" and "redistribution" of the content of all sorts of documents, "chapters, articles and illustrations extracted from books, journals and newspapers, off-prints, ephemera, photographs, etc.," were major functions of the Office of Documentation (Otlet, 1920). The creation of databases, or repertories in Otlet's terminology, derived from this need to go beyond the externalities of documents. But the repertory had many forms—"bibliographic repertories, repertories of documentary dossiers gathering pamphlets and extracts together by subject, catalogues, chronological repertories of facts or alphabetical ones of names, encyclopedic repertories of scientific data, laws, patents, physical and technical constants, statistics, etc." (p. 154)—All of these kinds of repertories or files were to be created and correlated within the Office of Documentation. A first approximation to what was needed were the specialist offices of documentation for hunting, fishing, polar regions and aeronautics that

Otlet and his colleagues had experimented with before the war.

The Universal Bibliographic Repertory can be considered at a general level to be the catalogue of an ideal, universal library. At a more detailed level it becomes the table of contents or the highly detailed index of the contents of a universal library. But ultimately one more step is needed in what Otlet called the "documentary edifice." This is the creation of the documentary encyclopedia from the indexed contents of the universal library. In essence, the encyclopedia *is* the Office. Within the Office of Documentation each of the databases, bibliographic, image, and textual, and each of the collections created by the application of the monographic principle, would be implicitly linked to each other through the use of the same database management system, UDC. Equally implicitly they would also be linked to relevant objects themselves for objects, too, must in an abstract sense be considered to be documents—hence, the imperative need for a museum to complement the bibliographic–bibliothecal components of the Palais Mondial or Mundaneum. The importance of this idea has recently been examined by Buckland (1991a, b). Responsive instantly and flexibly to the individual needs of clients, the Office Documentation, this revolutionized library, this future form of encyclopedia, is effectively a hypertext/hypermedia system.

MultiMedia Substitutes for the Book

So far this account of Otlet's ideas has been restricted to his attempts to create working organizations and services that were limited by the card and filing cabinet–based technology of his time. Discussed in these terms, an effort of imagination is required to appreciate their relevance to contemporary systems that are under development in a computer-based environment. But over the years Otlet became very much aware of new possibilities for information organization and communication offered by new technology. In the *Traité de Documentation* he expresses a vision of the future that is as revolutionary as Ted Nelson's Xanadu and not dissimilar. At the beginning of the century he had collaborated with the engineer, Robert Goldschmidt, in developing bibliographic applications of microfilm and these experiments continued into the 1920s (Otlet & Goldschmidt, 1906, 1925). In the late 1920s he and his colleagues attempted to use microfilm to create a new kind of information service and a version of the new kind of encyclopedia, the *Encyclopaedia Microphotica Mundaneum* in the Palais Mondial (Rayward, 1975, p. 297; Rayward, 1990, p. 208, 209). At about the same time, Otlet became aware of experimental attempts to establish commercial television (Rayward, 1990, p. 208). He understood that the emergence of television heralded something entirely new in the dissemination of information (Otlet, 1934). He believed that following the advent of the radio, "auditory documentation" should take its place alongside visual or graphic documentation. But this was only a beginning. He foresaw the emergence eventually of what he called tactile, gustatory, and olfactory documents—the "sense-perception-document"—in association with the other kinds of document (p. 429). All were forms of documentation and were complementary. "One after another," he observed, "marvellous inventions have immensely extended the possibilities of documentation." Such media as "telegraph and telephone, radio, television, cinema, sound recordings," as well as museum objects, all have similar aims to those of books—"information, communication"—but they achieve them differently. There was as yet, he believed, no collective name for them and so he proposed the term, "substitutes for the book." He devoted a major section in the *Traité* to an examination of their current state of technical development, their functional relationships and their implications for documentation (section 243, pp. 216–247). "The book," he concluded, "is only a means to an end. Other means exist and as gradually they become more effective than the book, they are substituted for it."

The Scholar's Work Station: a Hypermedia Memex

In the *Traité* Otlet is led from an analysis of multimedia substitutes for the book to speculate about the possibility of inventing new of kinds of intellectual machines and processes that he believed had now become both feasible and desirable. He identified a set of functions to be incorporated in one or more of these machines. The result was something akin to what today we would think of as the scholar's workstation, though some of the functionality envisaged by Otlet is still only a utopian glint in the inventor's eye. First, conventional work places needed improvements so that documents could be accessed and sorted more easily. There might be, for example, separate surfaces for different projects currently underway so that, as one task was interrupted when another was taken up, there need not be constant displacing and rearranging of materials. He suggested that this could be achieved by constructing a desk, following an eighteenth century model, in the form of a wheel the spokes of which would be hinged and would constitute freely movable writing surfaces. Moreover the desk should be surrounded by a great mobile filing cabinet which would always to open, at eye-level height, and within hand's reach. Mounted on a straight or circular rail, its movement controlled electrically, this is a striking physical surrogate for the files and databases now available in electronic systems.

Desks also needed to be fitted with "machines and auxiliary instruments of intellectual work." There should be machines to transform speech into writing and vice versa. It should also be possible, he believed, as an application of television, to allow texts to be made available for remote reading. There should be a device that would allow individuals to know of texts publicly displayed in various locations for this purpose. An extension of this idea was the suggestion that books on the shelves of a library or the contents of files in filing cabinets ought to be able to be inspected remotely as well. He was thinking of reading

machines scanning the physical items, while for us this function is performed by online access to machine-readable files. Similarly he thought that it should be possible to add long distance, as it were, to existing texts held remotely and to do this in such a way that the original texts were not disturbed. This idea of texts cumulating readers' annotation and commentary is seen as an important potential function of some hypertext systems (Davenport & Cronin, 1990; Landow, 1992).

Otlet's concern that the physical integrity of files subjected to these processes be maintained is revealing. It suggests that Otlet was very sensitive to one of the major limitations of the card-based systems he and his colleagues had introduced. To respond to requests for information, the staff of the search service in Brussels had to remove cards or other documents by hand from the files, copy them by hand and refile them by hand. This was a labor-intensive set of operations that was also liable to all sorts of errors of miscopying on the one hand and misfiling on the other. Moreover, materials sent in by collaborators from around the world had to be manually collated and filed in the databases by the OIB staff. Similarly, the information extracted from documents according to the monographic principle necessitated laborious transcription by hand or cutting and pasting. These last processes destroyed the integrity of the original and the possibility of other kinds of analysis, manipulation and reconstitution of the text that had not yet been anticipated. Online access to machine-held files or databases obviates all of these problems. It effectively meets the requirements that Otlet had formulated, but was unable to achieve, in the paper and card environment in which he functioned (Buckland, 1992).

Eventually, Otlet suggested, on the work desk there might be no books or other documents at all, but only a screen and a telephone. Somewhere outside, regardless of distance, would be

> ...an immense edifice containing all the books and the information, together with all the resources of space needed to record and manage them, with all of its apparatus of catalogues, bibliographies and indexes, with all the information redistributed on cards, sheets and files, and with search and retrieval [literally: selection and combination] performed by an appropriately qualified permanent staff (p. 428).

The workstation would be connected to this center by telephone, wireless telegraphy, television, and telex ("téléaugraphie"—elsewhere, p. 237, Otlet discusses "téléphotographie," which seems to be kind of telefacsimile transmission). The user would simply automatically call up on the screen the document or documents he or she wanted. The machine itself would operate one or more screens—as many as were necessary—to allow the simultaneous consultation of as many documents as might be desirable. A loudspeaker would give an extra, auditory dimension to the system and would allow text to be accompanied or augmented by sound. Effective consecutive transmission of information in the system would depend on the materials on which it depended having been recorded analytically in such a way that they could be automatically manipulated by "selection machines" (p. 428).

In another context, Otlet (1935) describes what he envisages in such a way that it is clear he has in mind machines that could create a "virtual" reality. He foresees the emergence of

> ...a machinery unaffected by distance which would combine at the same time radio, x-rays, cinema and microscopic photography. All the things of the universe and all those of man would be registered from afar as they were created. Thus the moving image of the world would be established—its memory, its true duplicate. From afar anyone would be able to read any passage, expanded or limited to the desired subject, that would be projected onto his individual screen, Thus in his armchair, anyone would be able to contemplate the whole of creation or particular parts of it. (pp. 390–391)

The invention of machines with these capabilities would help realize the new kind of encyclopedia that was the ultimate desideratum of documentation and would make it "very approximately, an annexe to the brain, the substratum of memory, an exterior mechanism and instrument of the mind, but so close to it and so fitted to its use that is would truly be a sort of appended, exodermic organ" (Otlet, 1934). As early as 1903, long before the sorts of development he described in the *Traité* stimulated him to technological speculation of the kind reported above, Otlet spoke of the practical aim of the science of bibliography as bringing into being "a machine for exploring time and space" (Otlet, 1903, p. 86). This image of a mechanical "brain" was to be echoed in his idea of a "World Brain" by H. G. Wells (1938) and by Bush in describing the functions of memex.

Universal Network for Documentation—an Internet

But the realization of these hypertext–hypermedia visions depended not only on the invention of new kinds of intellectual aparatus. They were predicated on a systematic organization of documentary work involving the cooperation of individual workers following standard practices for the creation, internal organization, publication, and processing of documents. These would facilitate the process of "division, dissection and redistribution of items of information" that was needed at the encyclopedic level or organization (Otlet, 1934, p. 396). But beyond them would come interrelated networks of libraries, archives, museums, and offices of documentation all following the same standardized methods of collection development and information processing. These networks would rise through the local and national to the international levels. Associated with them would be "ancillary documentary organizations" (p. 414) by which Otlet meant academies, scientific societies, research institutes, universities, and international

associations, all of which were concerned with documentation at some level of production, organization, or use. Ultimately, as this process of organization reached its apogee, a Universal Network for Information and Documentation would be formed which would link "centres of production, distribution, and use regardless of subject matter or place." The creation of the network "will ensure that anyone will be able to obtain what is offered with the least effort and with the greatest promise of certainty and abundance" (p. 415). All around the globe scholars and others through the Universal Network for Documentation would be drawing on and contributing to an ever-expanding, carefully managed body of knowledge universally available to all.

In this way Otlet envisaged the creation of "an enlarged supplement of [man's] memory" (Bush, 1945), "a... system that would eventually hold all the world's literature" (Conklin, 1987), "a kind of universal library of... text organized and indexed in new ways to facilitate the work of the user" (Tsai, 1988), a system that would "provide for the deposit, delivery, and continued revision of linked... documents, servicing hundreds of millions of users with hypertext, graphics, audio, movies, and hypermedia" (Rada & Lunin, 1986). (The words omitted are 'online' and 'electronic'). Here, then, dating back to the turn of the twentieth century in its essentials, is a formidable conception of a world brain, an adumbration of memex and the Internet, a highly elaborated system for the augmentation of the intellect, a vision of Xanadu.

But Is It Hypertext?

Some of Otlet's ideas are uncannily prescient of recent developments in the application of information technology. But, of course, Otlet was writing in a milieu that lay well outside the world of the computer and the ideas and speculations that it has generated, the social and "epistemological" developments that have gathered round it. It is important to understand the extent to which his thinking reflected and was inescapably determined by a social milieu and intellectual traditions that were quite different from those within which we operate today. He was not only not of our times, essentially he was not a twentieth century man at all; he was a conservative relic of the last quarter of the nineteenth. He identified a fundamental social problem. The problem is how most effectively to create, maintain, and change institutional arrangements for collecting, storing, preserving, organizing, retrieving, and disseminating all of the recorded information that is—or will be—needed within society. He dedicated himself throughout his long life with unflagging zeal to analyzing the dimensions of this problem and to exploring solutions to it. Yet he did this in ways that, from the point of view of those for whom there has been a paradigm shift, might well be described as ideologically doctrinaire and narrow minded.

In contemporary systems of information retrieval, the user—an abstraction not easy to interpret—is placed, at least by rhetorical convention, at the center of the systems. Some guiding notion of the user and his or her information needs and behavior has provided a fundamental point of reference for system development. This is so no matter how unfriendly and inadequate the systems may be in fact, no matter how egregiously system designers may have ignored the needs and capabilities of those for whom the systems were ostensibly created. It has been so from the days of primitive library use surveys and studies of information needs to the current interest in the "cognitive approach" to information system design based on models of cognitive structures and processes (e.g., Belkin, 1990; de May 1980; Ellis 1991, 1992). Otlet, however, displayed little or no interest in the user, other than in an extremely generalized sense. He certainly gave little or no sign of having a concept of user needs as we now understand them. His orientation was, on the face of it, completely different.

The modern primacy of the user in information systems comes out in a particularly interesting way in some of the general writing about hypertext systems. The text or document, is considered to be fluid, borderless, unbounded. It does not keep the form given to it by its author. In effect the modularization of the hypertext document is not only a form of decomposition of the document or documents on which the system is based, it may be construed as an act of repudiation of the authors' intentions in, and responsibility for, producing the documents in the first place. To speak only a little hyperbolically, documents can be considered to be, as it were, free floating text re-ordered and altered at the will of the user or the system designer or both. The text has no final, pre-determined shape but is endlessly re-created and changed by the user as he or she interacts with the system. Moreover, comments and criticisms of a text may be linked directly to it and any one text may be linked in all sorts of predictable and unpredictable ways to any other in the system. In this way, what Landow (1992) calls the "separation and univocality" of printed texts (p. 63) is destroyed. Hypertext becomes "textuality without bounds, a world without end or beginning" (Felperin, 1985). It is this boundlessness that leads to the fear that users of the systems will become lost in "hyperspace" and prompts the development of navigational devices.

In this way we may see hypertext as emblematic of the "deconstructionist" world of textuality and intertexuality of recent literary theory. In this world the trend to deal in "plural and deferred meanings" has led to the notion of the "endless interpretability of textuality" with the likely consequence for the author of being rendered "etiolated and anachronistic," if not dead (Felperin, 1985 p. 202). In effect, the traditional "status [of a text] as a transcription of experience and its author's claim to control the meaning of that transcription," says Felperin, "has now been undermined." As Landow (1992) observes, "In reducing the autonomy of the text, hypertext reduces the autonomy of the author." It reconceives "the figure and function of authorship" (p. 73).

User-Centeredness and Deconstructionism

Perhaps hypertext users who "access" documents, like those who read texts "deconstructively," may well be considered to engage something that is shifting, unstable, endlessly elusive as it transforms itself by what is brought to it in the very act of consultation. A request in Xanadu (Nelson, 1987), for example, "may bring back a shower of fragments from the separate documents of origin on different storage machines, which are assembled by the user's front-end program" (p. 145). At another level of analysis of hypertext system capability, however, reconstruction is possible. Users request parts of "virtual" documents and "need not be aware (but may find out) what documents their fragments originally came from" (p. 145). That is to say in hypertext systems the original form of the text is not destroyed and may be recoverable and reconstitutable, just as the physical manifestation of a printed text undergoing a "deconstructive" reading remains available, "separate and univocal," to other readers. Indeed, this recoverability is an essential feature of Xanadu. Here the system provision of a capability for "arbitrary collage" is balanced by the provision of a capability for "historical backtracking" through document versions or states. The very notion of system navigation in hypertext must presumably also encompass return to a departure point. Whatever has been broken down or modularized and then connected by whatever associative links individual users have created for their own idiosyncratic purposes may be reconstituted, one assumes, into an "original" order and form.

An Outmoded Paradigm: Nineteenth Century Positivism

Landow (1992) is sympathetic but firm when he deals with those "who yearn to retain older conceptions of authorship or of the author function." For him it is clear that "lack of textual autonomy, like lack of textual centeredness, immediately reverberates through conceptions of authorship as well. Similarly, the unboundedness of the new textuality disperses the author as well" (p. 74). But Otlet's refusal to accept textual autonomy in his hypertext-like schemes, suggests an alternative outcome from that described by commentators such as Landow. He could only have been appalled by the deconstructionist, postmodern interpretations of text and hypertext. Otlet's primary concern was not the document or the text or the author. It was also not the user of the system and his or her needs or purposes. Otlet's concern was for the objective knowledge that was both contained in and hidden by documents. His view of knowledge was authoritarian, reductionist, positivist, simplistic—and optimistic! Documents are repetitious, confusingly expressed and filled with error as well as with what is factually true and, therefore, of use. But he betrays no doubt that what is factually true and likely to be useful can easily be identified. It is merely a question of institutionalizing certain processes for analyzing and organizing the content of documents. For him that aspect of the content of documents with which we must be concerned is facts. He speaks almost everywhere of *facts*. It is clear that for him a primary requirement of the new kind of systems that he believes must be developed is that they have the capability of securing the release of valuable information, what he would call facts, from the documents that hold and hide them. For Otlet it is not a case of how these new systems will respond adaptively to the incalculably various and idiosyncratic approaches of users. He is concerned with the way in which broad categories of users from various realms of intellectual and social endeavor will be able to use and benefit from what the systems provide. It is the user who must adapt to the systems not the systems to the user.

What these systems provide are nuggets of information that have been purified of "all dross and foreign elements" (Otlet, 1903, p. 84) that accumulate around them as authors embed them in the documents that they create for a range of their own idiosyncratic purposes and with varying degrees of expository success. If authors would accept the kinds of discipline in producing documents represented by the procedures, the "rules and regulations," recommended by Otlet (1920, p. 186), then all of what is original and a contribution to knowledge in what they wrote would become easily identifiable for assembly into a single, coherent corpus, "the great body of the sciences" (p. 178). This would then contain all that has been established as true—and would constitute a new form of encyclopedia. In effect, Otlet suggests that we should be able to remove facts from documents rather like we shell peas from their pods. Otlet does not address the question of how what has been established as true is to be recognized. Presumably experts will be able to identify what is of value in the documents as they are processed in the Offices of Documentation. Ultimately the function of the offices in this process of assembling and integrating information in documents, as I have indicated above, is "codification." This means not flexible, multiple expressiveness but simply "not saying something more than once." It means organizing ideas in such a way that "principles, standards, laws and rules" are created (Otlet, 1934, p. 411). Through the new systems that he is proposing appropriate new knowledge will be "brought to the notice of those who must act so that their action will be more useful, more extensive, in better accord with the action of others, better subordinated to more general goals—in a word...more efficient" (p. 178). In this connection the synthetic qualities of the UDC and the flexibility that these qualities imply are important primarily for encoding complex subjects and subject relationships. Their value for database searching to meet complex and variable user needs is not a subject addressed directly at all.

As a young student, Otlet was under the tutelage of Jesuit teachers and professors for most of his formative years, certainly more than the critical seven. As a teenager he saw himself engaged in the contest between science and religion. He committed himself finally and after a great spiritual crisis to the principles of positivism, progress, and evolution, to the grand theories of Herbert Spencer

and his contemporaries in which these traditions were fused and applied to social organization (Rayward, 1975, ch. 1). These early intellectual struggles marked Otlet for life. He never moved in his thinking from the positions he adopted as a young man and which were popular in the educated, upper middle class circles—tinged with a faintly iconoclastic socialism—in which he moved. He saw great, rational, generalizing, progressive organizational forces at work throughout society. He saw his work as harnessing these forces in institutions of ever-widening scope first in the International Institute of Bibliography, later in the Union of International Associations and later still, in the League of Nations. In the last case, however, he and his colleague, Henri La Fontaine, failed to secure any significant support for their schemes in the League's International Committee, and later Institute on, Intellectual Cooperation.

But there was nothing strange for him or, at least for a time, for his contemporaries, in suggesting—prescriptively and in an *a priori* way—how all of the forces in the world of books and knowledge might be organized rationally to facilitate the production and assembly of knowledge into a single, physical, "mechanically" accessible corpus. After all, he seems to suggest, science produces in a quite straightforward way discrete, objective elements of knowledge. These give rise in an equally straightforward way to laws and generalizations. The need to identify and manipulate the former in order to help produce the latter underpin Otlet's conceptions of the functions of the Offices of Documentation.

The metaphors that Otlet used are revealing (e.g., 1892). He wanted to "winnow" documents of their best grain and continuously "to map" all of the intellectual domains. "Mapping" assists exploration by reducing unnecessary voyages over already discovered terrain. And as "maps" of ever-decreasing scale are produced, they record and organize ever more detailed features of the landscape. "Winnowing" involves harvests in which nothing of value is lost and where the yield, the staple of intellectual life, is stored in an orderly, easily accessible granary for use.

Otlet's thinking must be placed within a nineteenth-century Kuhnian paradigm of positivist science, of the creation of dissemination of knowledge, that has long since been superseded. It can be argued that the solutions Otlet proposed for the problems of information storage and retrieval that were his almost obsessive concern failed because they reflected a naive view of the nature of knowledge and the dynamics of its growth. Otlet underestimated the complexity of the physical and social processes of scholarship and of the broader culture which supports these processes. The First World War marked the end of the intellectual as well as sociopolitical era in which Otlet had functioned hitherto with remarkable success. After the war, he and his schemes were never taken seriously except with the circle of his disciples. He quickly lost the support of the Belgian government. In the late 1920s he faced the defection of his followers in the International Institute of Documentation, as the International Institute of Bibliography became in 1931 (it is now the International Federation of Information and Documentation, FID). His frequently repetitive writing often took the form of lists of desiderata. These were intended to be adopted by and shape the objectives and procedures of international organizations but they tended simply to be declared rather than carefully argued and justified. The powerful individuals and groups over whom he had exerted a great deal of influence in Belgium and in the international arena before the War became, after it, unresponsive to prescriptive pronouncements that required sweeping reformist change in institutions and their practices.

What Otlet was describing and publicizing so persistently for 40 years was similar in some respects to modern notions of hypertext. But it was quite different from a hypertext centered on assumptions about the user and his or her preeminence in driving the hypertext machinery. At first sight there is a startling contrast between what Otlet was writing about and what Landow and others who are interested in understanding hypertext in terms of modern critical theory are describing. But when posed in this way, the difference makes us look a little more closely at what some of the accounts of modern hypertext systems, especially in their grandiose, theoretical, "macrotext" manifestations, are actually saying. Is it possible that, despite the rhetorical flourishes, there is, deeply embedded in the accounts of some of these systems, what might be described as a "remainder" of nineteenth-century positivism?

Is it possible that they imply an outlook on the nature of knowledge that, if one reads the texts "deconstructively," suggests a irony at their center—a limited, essentially reductionist view of objective, "scientific" knowledge, rather than the endlessly various user constantly creating and recreating necessarily unstable texts? In describing the Xanadu Project, Nelson (1987) for example, in capital letters, says that it is "just one thing: a new form of interconnection for computer files—CORRESPONDING TO THE TRUE INTERCONNECTION OF IDEAS which can be refined and elaborated into a shared network" (p. 143). These words and the sentiments that they both express and seem to imply could be, except for the term "computer files," Otlet's own. They suggest an atavistic positivist perspective that takes one by surprise. And though one might describe Otlet's views of the functions of Offices of Documentation in correlating and codifying knowledge as being couched in the conceptually antiquated terminology of an old paradigm, how easy is it to dismiss them in the light of the recent work of Don Swanson? Swanson has shown how what he has described as previously undiscovered public knowledge may be extracted from bodies of literature that are logically related but unconnected by citation (e.g., 1986, 1990)—processes that certainly would be appropriate to the Office of Documentation as conceived of by Otlet.

Note: Some of the ideas in the first part of this article were the basis of a presentation by Professor Michael Buckland on behalf of both of us at the Fall 1992 meeting

of the American Society of International Science which I was unable to attend. I am indebted to Prof. Buckland for encouraging me to explore Otlet's ideas in relation to hypertext. Prof. Buckland has himself been examining some of the implications of Otlet's work as a pioneer of information science (e.g., Buckland, 1991a–c).

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